

THE AGRICULTURAL COLLEGE

EXTENSION BULLETIN

VOLUME VIII

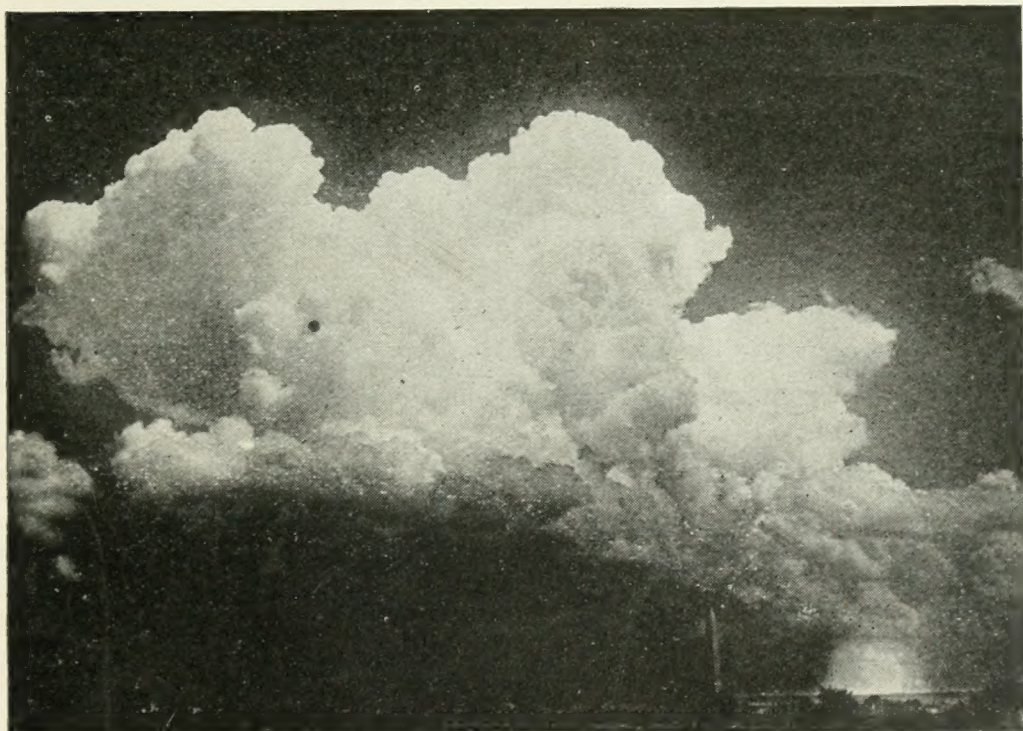
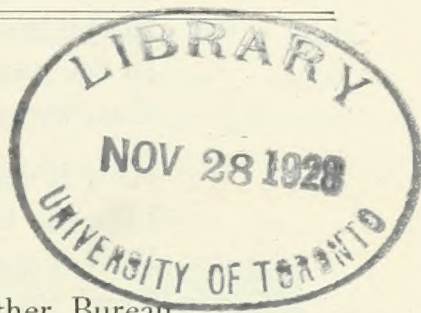
NOVEMBER, 1912

No. 3

RAIN

By J. WARREN SMITH,

Professor of Meteorology, U. S. Weather Bureau



It hain't no use to grumble and complain;
It's jest as cheap and easy to rejoice.—
When God sorts out the weather and sends rain,
Why, rain's my choice.

—From Riley's *Neighborly Poems*.

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RAIN

How beautiful is the rain!
After the dust and heat,
In the broad and fiery street,
In the narrow lane,
How beautiful is the rain!

How it clatters along the roofs,
Like the tramp of hoofs!
How it gushes and struggles out
From the throat of the overflowing spout!

Across the window pane
It pours and pours;
And swift and wide,
With a muddy tide,
Like a river down the gutter roars
The rain, the welcome rain!

* * * * *

From the neighboring school
Come the boys,
With more than their wonted noise
And commotion!
And down the wet streets
Sail their mimic fleets,
Till the treacherous pool
Ingulfs them in its whirling
And turbulent ocean.

In the country, on every side,
Where far and wide,
Like a leopard's tawny and spotted hide,
Stretches the plain,
To the dry grass and the drier grain
How welcome is the rain!

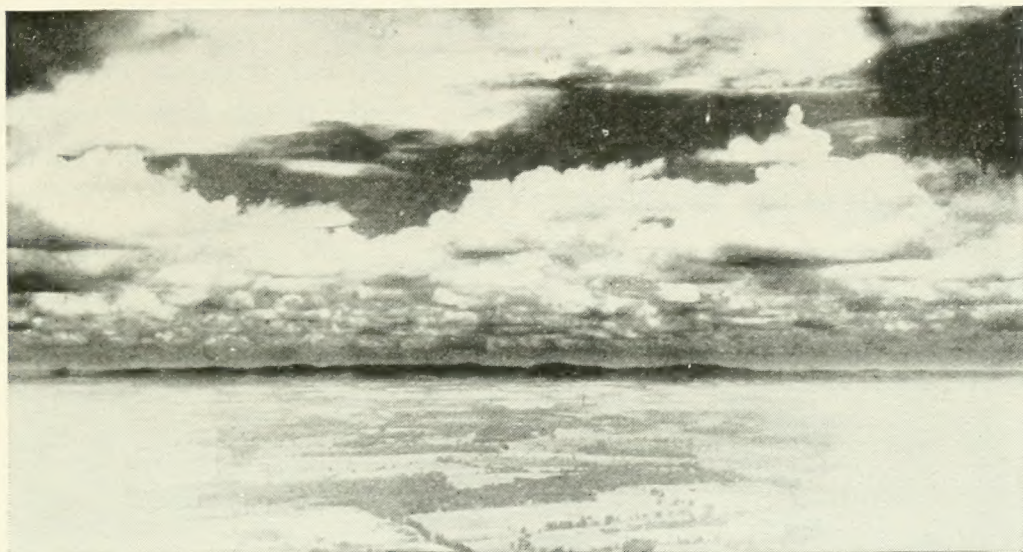
* * * * *

—Henry Wadsworth Longfellow.

RAIN

J. WARREN SMITH

It is so windy in Chicago that it is said one can always tell a man from that city by the way he grabs his hat whenever he turns a street corner. Also as it is so rainy in Buffalo, men from that city can always be recognized, because they carry their right hand clasped with the thumb up as if they were carrying an umbrella.



Cumulus Clouds. These are typical summer time clouds and indicate fair weather conditions. They are flat bottomed with rounded tops and are visible tops of ascending currents of air. The air expands and cools as it ascends and when the temperature of condensation or dew-point is reached clouds are formed.

Water Vapor in the Atmosphere

Dove has said: "The atmosphere is a vast still, of which the sun is the furnace, and the sea the boiler, while the cool air of the upper atmosphere and of the temperate zones plays the part of condenser, and we on a wet day, catch some of the liquid which distils over."

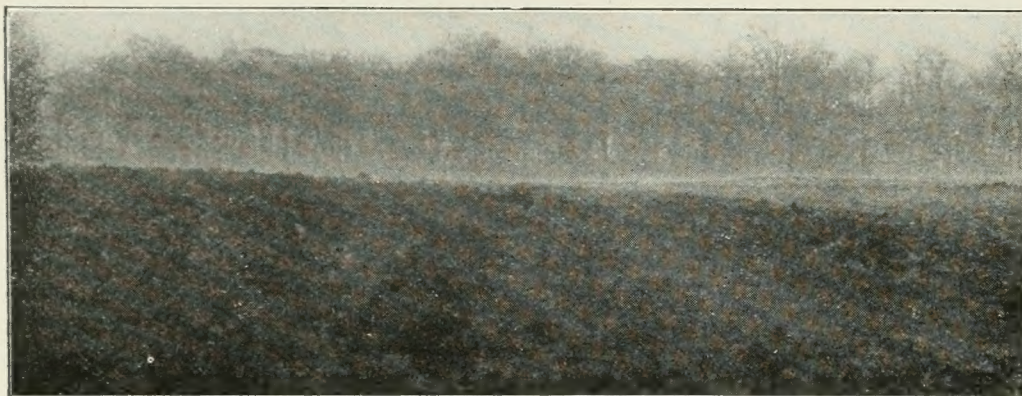
Water vapor is one of the most important constituents of the atmosphere which surrounds the earth. It is essential to animal and vegetable life, and yet on a cold winter day it may not comprise more than .001 part of the atmosphere, and its maximum on a warm summer day near the seashore is never more than about .05 of the atmosphere.

The temperature determines the amount of invisible moisture that the atmosphere can contain, as is shown by the following table:

Table 1. Weight of water vapor in the atmosphere when completely saturated.

Temperature Degrees F.	Weight of a cubic foot of saturated vapor. Grains troy.
100	19.766
80	10.933
60	5.744
40	2.849
20	1.235
0	0.481
—10	0.285
—20	0.166
—40	0.050

This indicates that at a temperature of 40° it is not possible for the air to contain more than one-half as much water vapor as it can at 60°. Almost one-half of the total water vapor in the whole envelope of air that surrounds the earth is within one mile of the earth's surface, while one-half of the atmosphere is above 3½ miles.



Fog appeared over this newly plowed field only at eight o'clock in the morning.
The air above the field was just cold enough to make moisture escaping
from the field visible.

At a height of 6 miles above the surface of the earth, where the temperature is about 60° below zero, the total amount of water vapor is only 0.01% of the atmosphere.

Saturation

When the air holds one-half as much water vapor as it is possible for it to hold at that temperature we say the relative humidity is 50%. When it holds three fourths of its capacity the relative humidity is 75%. When the relative humidity is 100%, the air is said to be completely saturated, and will take up no more water by evaporation, while at that temperature.

A room 20 x 20 feet and 10 feet high contains 4,000 cubic feet of air. If this air is completely saturated at a temperature of 80° there would be 3 quarts of water in the atmosphere in an invisible form. If the temperature should be 60° only 3 pints of water could be held in suspension in the atmosphere of the room. If the temperature of the air should be zero, it could contain less than 0.3 of a pint of water.

Condensation

It will be perfectly plain from the last paragraph that if the temperature in this room should be at 80° with the air completely saturated, and then the temperature lowered 20° , about one-half of the water vapor would be forced out of the atmosphere and would condense in visible drops. This condensation would take place upon clothing or on other objects in the room or on dust particles.

If the temperature of the room were at 80° and the air three-fourths saturated (the relative humidity, 75%), the temperature of complete saturation or dew point would be passed if the temperature should be lowered to 70° , and visible condensation would begin.



At nine o'clock the same morning, the moisture is escaping but the air is warm and it can not be seen. Less moisture would have escaped had the field been harrowed very soon after plowing.

What Makes it Rain?

It is not possible for cold air to hold as much moisture in the form of vapor as warm air will hold. With each fall in temperature of about 20° , the air can hold only one-half as much vapor as at the higher temperature.

Rain is caused then whenever a large mass of air is cooled below its dew point or temperature of complete saturation. Clouds are formed just as soon as the dew point is passed and condensation into visible drops begins to take place. If the cooling continues, large drops will be formed from the smaller cloud particles and these drops will fall to the earth as rain.

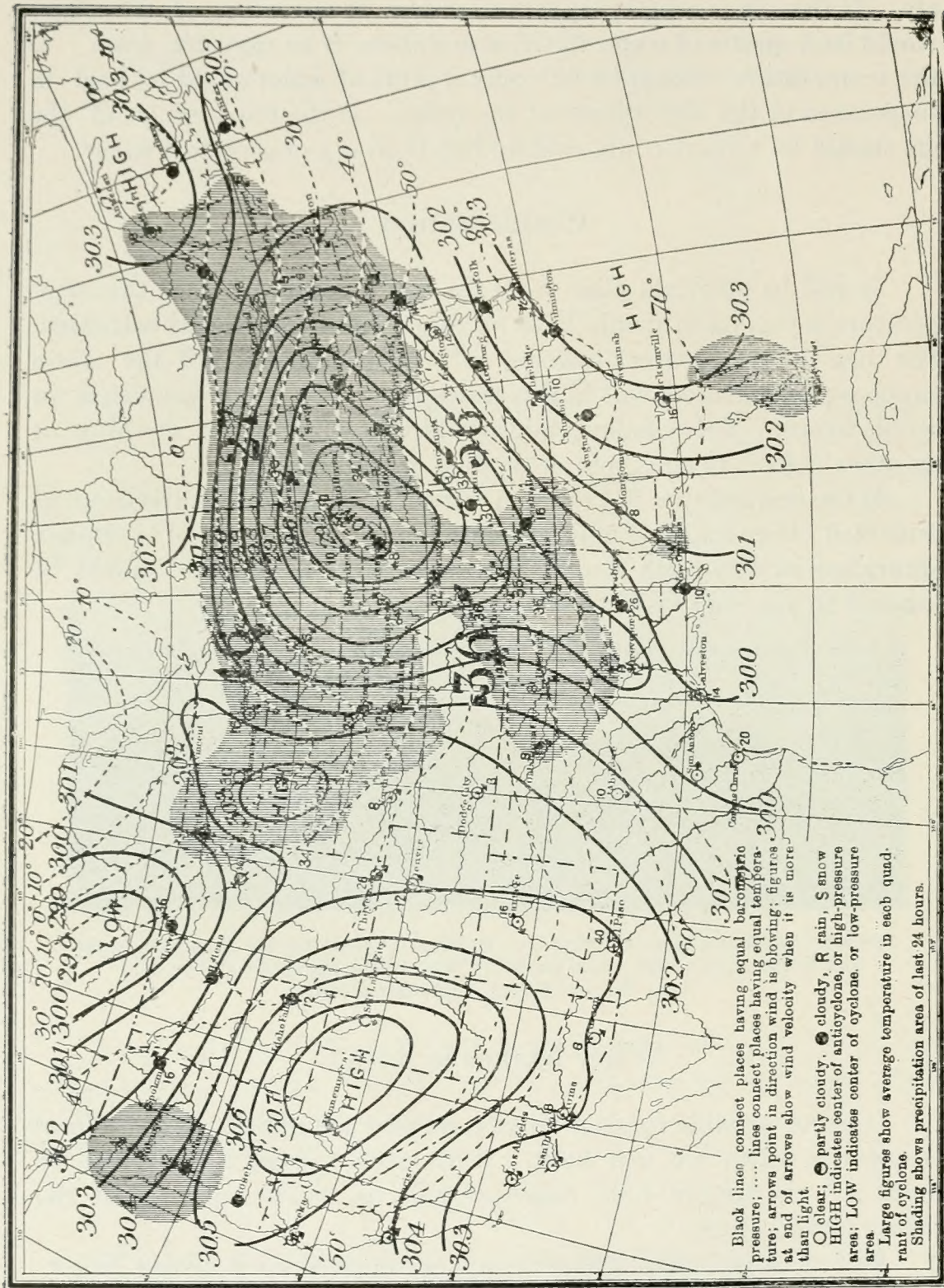


Chart No. 1, December 15, 1893, 8 p. m. This shows a typical winter storm that is centered over Lake Michigan. The air is flowing in toward the center of low pressure areas and is rising near the center. Stormy weather prevails because the air is cooled by expansion, in rising, and its capacity for moisture is decreasing.

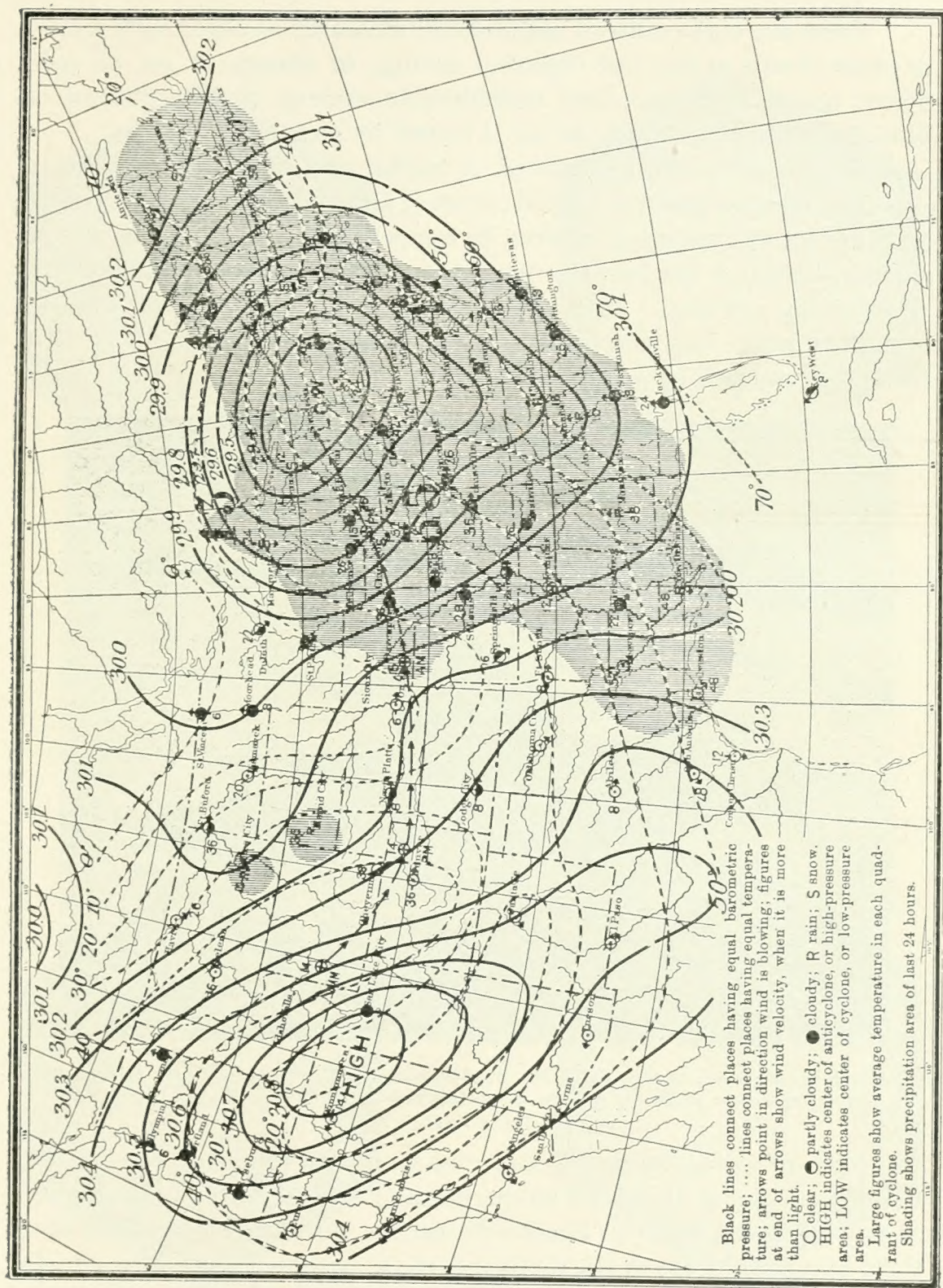
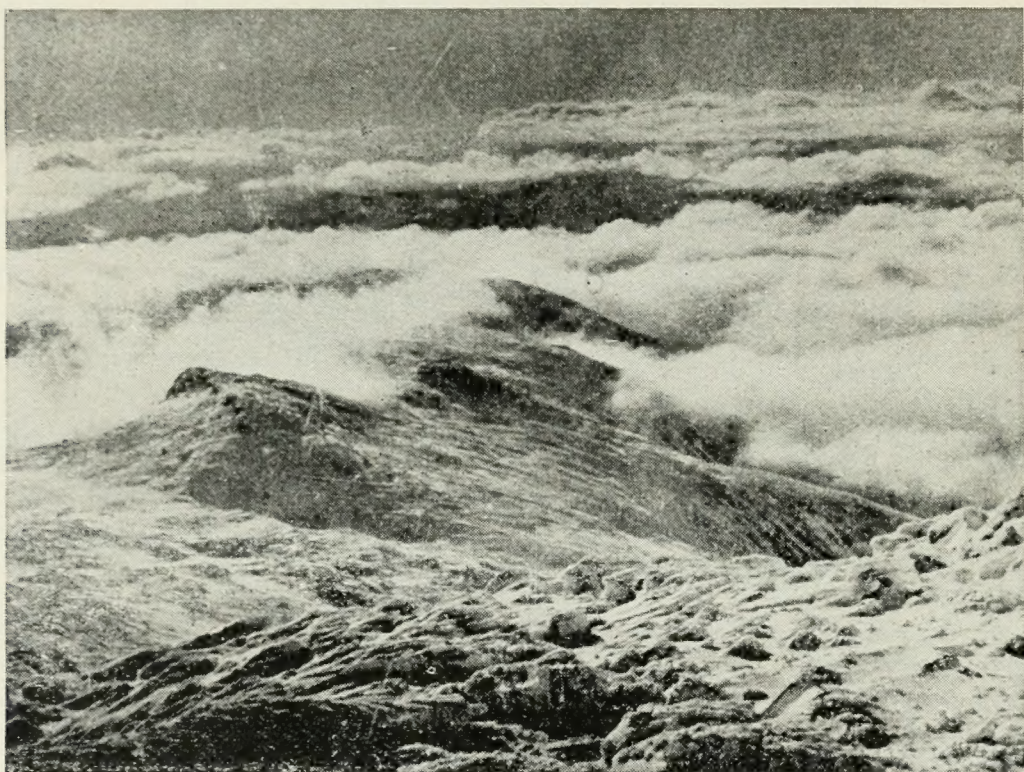


Chart No. 2. December 16, 1893, 8 a. m. This chart shows the weather conditions 12 hours later than chart 1. The rain area has advanced eastward with the low pressure center. The air is descending in the high pressure areas, and as it is warmed by compression as it descends to lower levels its capacity for moisture is increasing, and mostly clear skies prevail.

How is the Air Cooled?

There are eight natural methods by which air is cooled sufficiently to cause clouds or fog, but vigorous cooling in masses of air of sufficient quantity to cause any considerable amount of precipitation is brought about only when the air is cooled by expansion.

When a mass of air is carried to higher altitudes by any cause it expands, because there is less air above it and the pressure on it is less and this act of expansion reduces its temperature. The rate at which it cools, before it reaches the temperature of complete saturation, is 1° for every 178 feet. After condensation begins, the rate of cooling is slightly less. Conversely, if a mass of air is carried to a lower altitude, it is warmed by compression at the same rate.



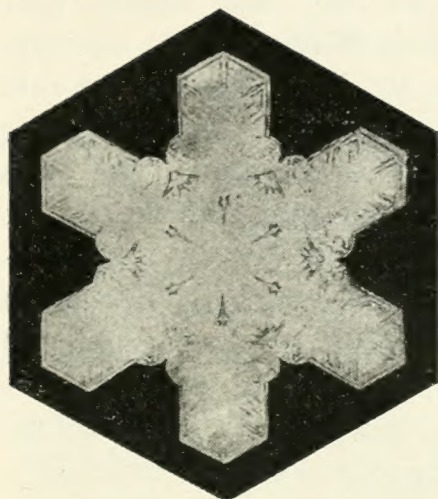
"Above the Clouds" on the top of Mt. Washington, N. H. It is sometimes raining in the valley below while on the top of the mountain, above the clouds, the sun is shining brightly.

Remembering the figures in connection with the room, we can see that if a current of air with a temperature of 80° and a relative humidity of 75% is forced up to 10 times 178 feet, or but little more than one-third of a mile, some of the moisture must be condensed into clouds and rain.

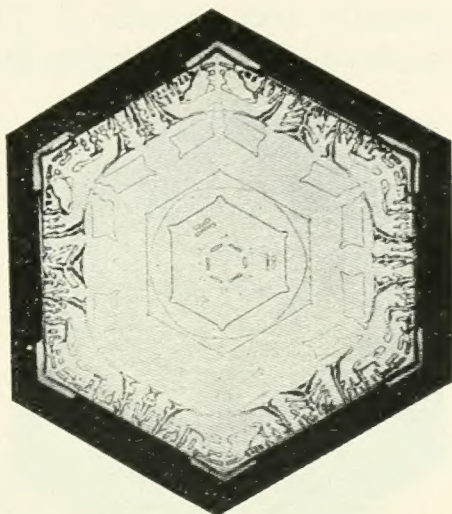
Ascending air then is cooling and is apt to be cloudy and rainy; descending currents of air are warming, the capacity for moisture is increasing instead of decreasing and they are most apt to be accompanied by clear skies.

Different Types of Snowflakes

Always Six Sides or Six Points



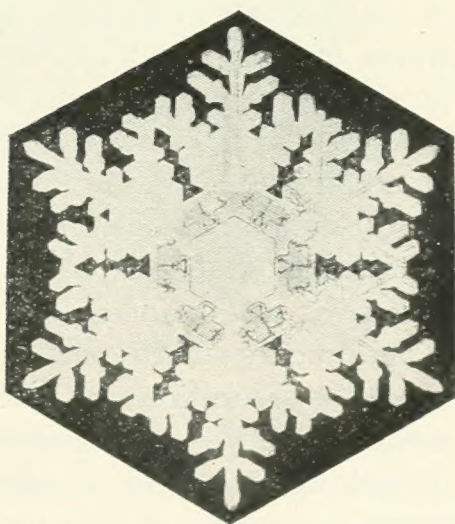
A very rare type.



Solid tabular. This fell from the upper atmosphere.

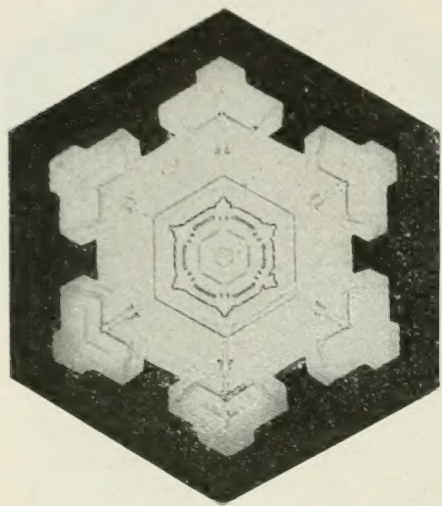


"Fern stellar." This snow flake was formed near the surface of the earth.



A combination of solid tabular and fern stellar type. The center was formed in the upper air and condensation continued as it fell through the lower atmosphere.

In charts 1 and 2 the arrows show that the wind is blowing toward the areas of low barometric pressure from distances covering several hundred miles. As these currents of air flow toward the areas of low pressure over country of different elevations they will hardly flow horizontally but will rise or fall somewhat. Wherever the currents



A rare and beautiful type of snow crystal.

dip down the air is warmed at the rate of 1° for each 178 feet; and wherever they rise to higher elevations the air is cooled at the same rate. If the rise is sufficient to cool the air past the temperature of complete saturation then clouds and rain will result in that region. If on the other hand, the currents dip downward an area of clear skies may occur even in an area of general rainfall.

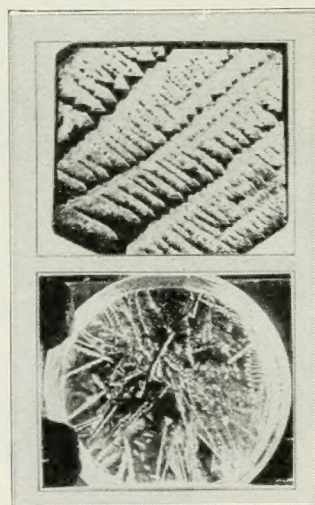
Near the center of the low pressure areas the air is carried sharply upward and hence rain nearly always prevails all about the center of the cyclonic areas.

Rain sometimes falls from a mass of air that is flowing from a warm toward a colder region, but this is not usually heavy or of long duration unless cooling by expansion accompanies the process.

Rain in Thunderstorms

Thunderstorms occur whenever there is a rapidly ascending current of very moist air. Unstable equilibrium is produced when a mass of cold air overlies a region of very warm air, whether it is produced by the undue warming of the lower air or by the flowing in of cold air above a body of warm air. In either event there is a tendency for the cold air to descend and the warm air to be forced up in violent rushes, and thunderstorms will be formed. This rapidly rising air is quickly cooled past the temperature of complete saturation and rain results. When new masses of warm moisture-laden air flow in and up, moisture condenses rapidly and heavy downpours of rain occur. See picture on cover page.

Thunder storms usually move eastward with the general air drift and, as masses of air flow constantly in from either side, heavy rain accompanies the eastward movement.



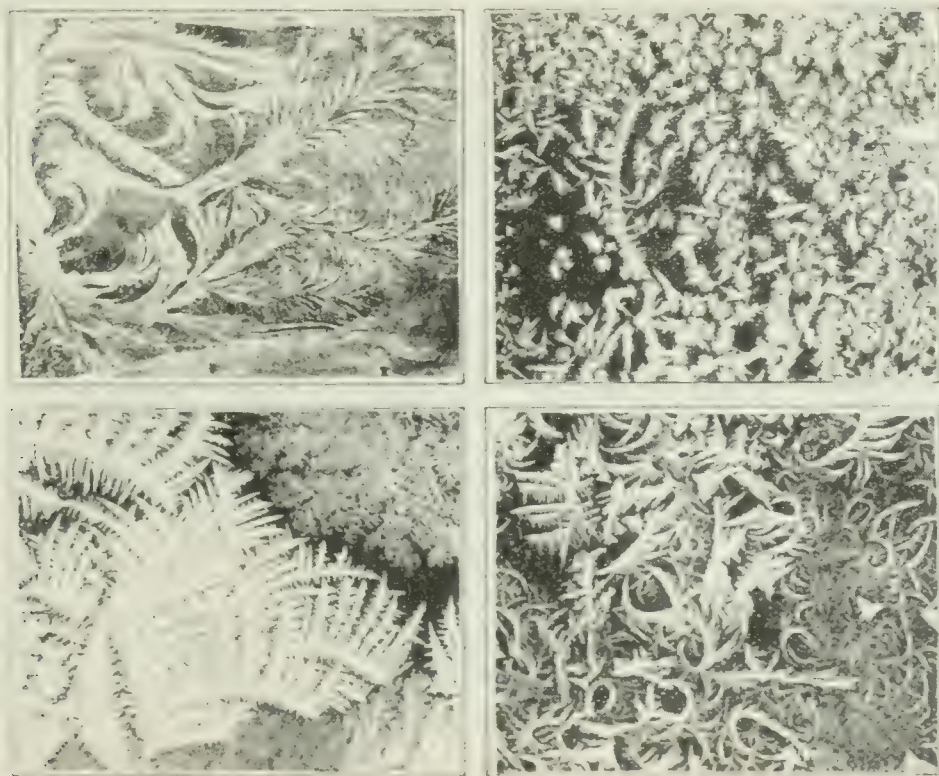
Ice crystal in water pail. The upper half is a magnified section of the lower half.

Whenever for any reason the center of the rapidly ascending currents of air remains nearly stationary, cloud-bursts, so-called, occur and the rainfall is excessive.

Character of Precipitation

When condensation is sufficiently vigorous to cause precipitation while the temperature is below the freezing point, snowflakes will be produced.

Sleet is formed when raindrops from a warm upper air current are frozen in passing through a colder layer of air near the surface of the ground; also when snow from a colder upper current is partially melted in passing through a warmer lower current.



Photographs of ice crystals on the window pane.

Hail seldom falls except during summer thundershowers. Hailstones are composed of concentric layers of ice and snow. They are usually spheroidal in form, but are sometimes oval, sometimes flattened, and sometimes very irregular in shape.

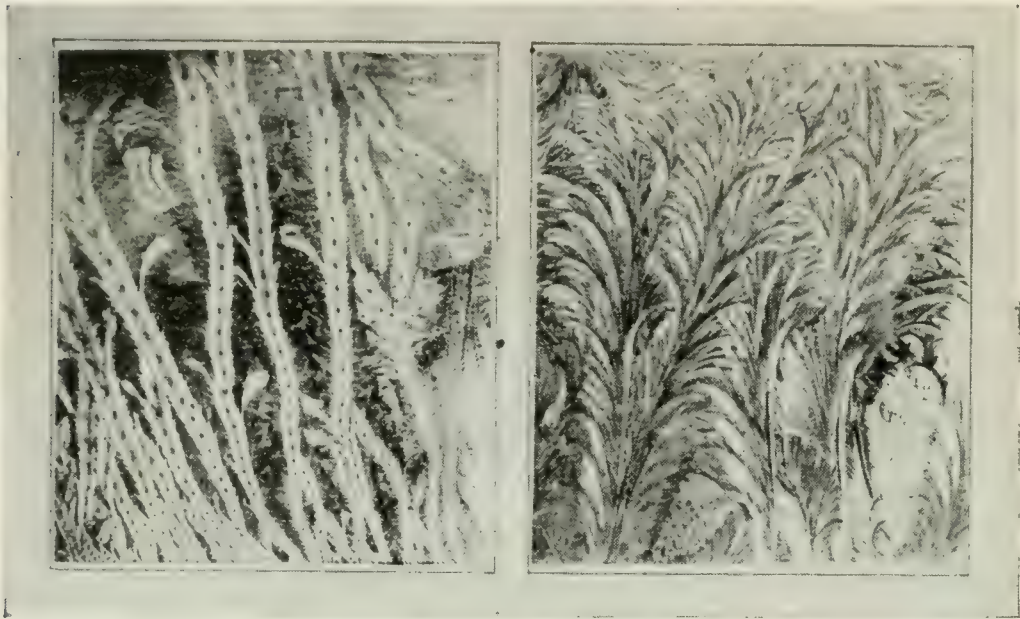
Rain sometimes falls from a clear sky, but the amount is small and the conditions must be such that rapid condensation takes place near the ground.

Rain and snow also may sometimes be seen falling from a cloud,

but the visible moisture is evaporated before reaching the ground. This is not an uncommon sight in the semi-arid region of the West.

Distribution of Rain

The rainfall of the whole globe, including both land and water areas is estimated to be about 5 feet a year. Of the land areas of the globe, 6% receives 75 inches or more a year, 16% receives 50 to 75 inches; 25% receives 25 to 50 inches; over 30% receives 10 to 25 inches; 20% receives less than 10 inches.



Ice crystals on window panes.

Heavy Rainfalls

The place of greatest recorded rainfall is Cherra Punji, Assam, India, where the average is about 500 inches a year. In 1861 the rainfall there was 905 inches. In August, 1841 it was 264 inches. On July 12 to 16, 1876, 114 inches fell, and on the 14th, 40.8 inches. At Suva, Fiji, on August 8, 1906, the rainfall was 40.98 inches.

At Helen Mine, Lake County, California, the rainfall during the month of January, 1909, was 71.54 inches. Rainfalls of 8 to over 10 inches in one day have occurred occasionally in the United States.

Volume of Rainfall

The table following shows the quantity of rainfall corresponding to given depths.

Table 2. Quantity of water in rainfalls.

Depth of rainfall in inches.	Gallons per Acre.	Tons per Acre (2,000 lbs)
0.01	271.5	1.1
0.05	1,358.	5.6
0.25	6,789.	28.0
1.00	27,154.	113.0
5.00	135,772.	565.0

In September, 1866, the average rainfall for 28 stations in Ohio was 9.67 inches. If this may be considered as representing the fall over the whole State, the total waterfall in Ohio that month amounted to 6,900,233,327,177 gallons, or 28,825,844,520 tons of water.



Cirri-cumulus clouds, often called "Wool-pack" clouds.

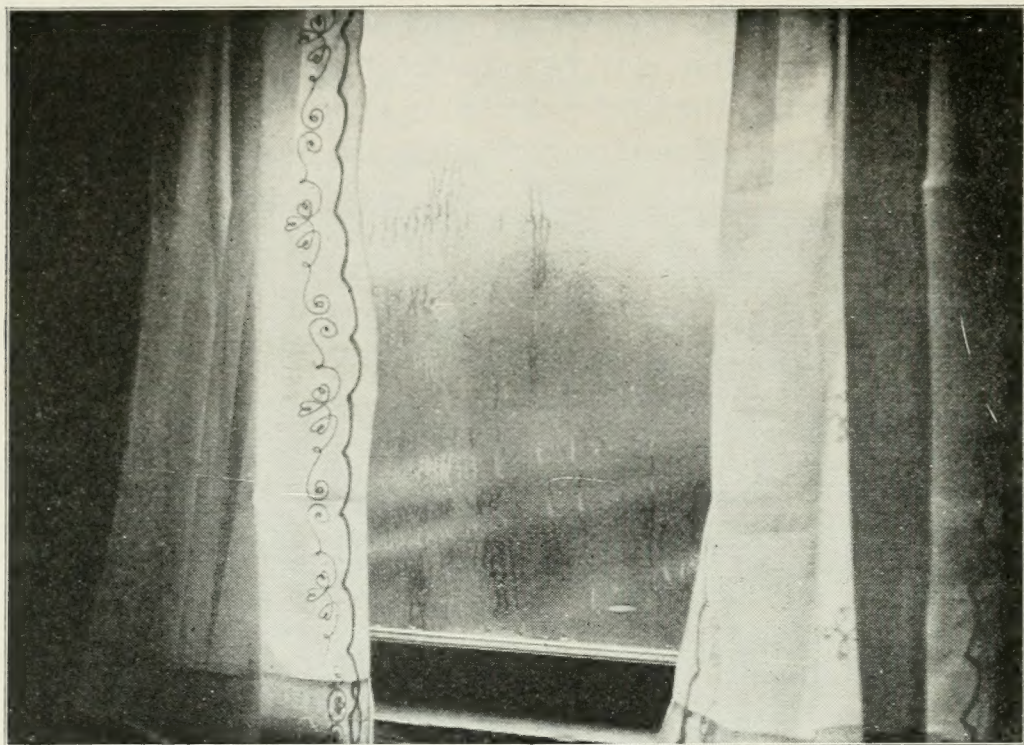
Value of Rain

In Jamaica, W. I., an increase in the annual rainfall from 56 to 76 inches increases the yield of sugar about one tenth, valued at \$400,000. In the Barbadoes, each inch of rainfall increases the yield of sugar one nintieth of a hogshead per acre.

In Australia where the annual rainfall is from 8 to 10 inches they can graze only 8 or 9 sheep per square mile; where the rainfall is 13 inches they graze 96 sheep per square mile, and where 20 inches, 640 sheep. In Buenos Aires where the rainfall is 34 inches they graze 2630 sheep per square mile.

In Ohio in a record covering 54 years, for every increase in the rainfall in July amounting to 1 inch, the increase in the value of the corn raised amounts to over \$2,000,000.

In the eight great corn states in the central part of the country an increase of 1 inch in the rainfall at the critical rainfall point makes an average increase in the value of the corn crop amounting to \$180,000,000.



Cold air outside has condensed moisture on the inside of window pane. The gradual accumulation has caused drops to run down the window.

Water in the Air

Why do ponds "dry up"?

Why do teakettles boil dry?

What becomes of a basin of water if set in the sunshine?

Do clothes dry more quickly on a windy or a calm day? In the sunshine or shade? On a cold or warm day?

Why do we sometimes blow upon hot water?

Where do the clouds from locomotives go?

Where do clouds come from? Where do they go?

What moves clouds? How fast can they travel?

How high are the clouds?

Do you know the story of "Franklin and his kite"?

Were you ever above the clouds?

Have you ever heard of "the battle above the clouds"?

How can clouds above us be moving in several directions at the same time?

Has every cloud a "silver lining"?

Draw all the forms of clouds that you can see.

Where does dew come from? When does it form?

How long does it remain? Where does it go?

Does dew fall? Why does an ice-pitcher "sweat"?

Why does moisture (dew) collect on the windows in winter?

What forms the drops of water there?

When can we see our breath? What part do we see?

Why does not moisture gather on hot stoves?

Are all raindrops equally large?

Do you know any signs of rainy and fair weather?

Why is rain fresh when it comes from the ocean?

Conditions of Water

Does it ever rain in winter, or snow in summer?

How many rays has every perfect snowflake?

Why do we sometimes bank our houses with snow?

Is a snow-house warm or cold inside?

From what do Esquimaux build their huts?

Does the ground freeze deeper when bare, or when covered with snow?

Of what use is snow to trees?

Is a thawing day warm or cold?

What makes crust form on snow?

When will snow make good balls?

Does snow melt first in a forest or open plain?

In which seasons do we have hail-storms?

What is in the center of a hailstone?

Are all hailstones of the same size and shape?

What damage is caused by hail?

What are the differences between frost and dew?

When and where does frost form?

Does it form on windy or calm nights? When the night is cloudy or clear?

Why cannot frost form near cracks in a window pane?

—From Frye's Child and Nature

More Help

Those interested in an elementary discussion on the subjects named below can secure the bulletin by requesting it. The College of

Agriculture is doing all in its power to furnish publications on the most popular subjects in Nature Study and Agriculture.

Corn Culture
House Fly and Blow Fly
Beneficial Habits of Snakes
Judging Cattle
Soil Formation
Drainage
Weather Forecasts
Cone Bearers and Evergreens
Transplanting
Weeds
Propagation of Plants
Orcharding
Pruning and Spraying
Making Good Earth Roads
Poultry Feeding
Butter Making
The Canning of Fruits and Vegetables
Fruits and Vegetables
Jellies and Jams
Bread and Bread Making
Sanitation
Sewing
Vegetables—How to Cook Them
Kitchens
Meats

Farmers' Week

During the week February 3-7, 1913, only one Extension School will be held outside of Columbus. A School of one week will be held at this time at the College of Agriculture, Columbus, Ohio, at which all the courses offered to men and women in an Agricultural Extension School will be given by the instructional force of the Extension Department.

Boys' and Girls' Week

During the same week, a special course in Agriculture will be offered for boys and a special course in Home Making for girls. There is no age limit, but it is believed that those under the age of fourteen will not receive the greatest benefit from the work. If further information is desired about these courses write A. B. GRAHAM, Superintendent Agricultural Extension, Columbus, O.